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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
400 MARYLAND AVENUE, SW, WASHINGTON 25, D.C.
TELEPHONES: WORTH 2-4155——WORTH 3-1110

FOR RELEASE: UPON DELIVERY

Address at the Governor's Dinner
by
James E. Webb, Administrator
National Aeronautics and Space Administration

WESTERN SPACE AGE INDUSTRIES AND
ENGINEERING EXPOSITION AND CONFERENCE
San Francisco, California
April 24, 1962

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"The National Launch Vehicle Program"

Governor Brown,

Good evening. It is a pleasure to take part with the Governors of these 13 Western states in an Exposition and Conference that will emphasize the dynamic role of space science and technology in this rapidly growing region of our country. I appreciate the invitation of Governor Pat Brown to meet with you. I also appreciate the opportunity to appear in California with the Honorable George P. Miller, Chairman of the Committee on Science and Astronautics of the House of Representatives. This Committee, established in 1959 and one of the newest of Congressional Committees, now handles many of the most important issues before Congress. The role and use of science and technology have become basic to almost every governmental policy or program.

In this situation, the State of California is fortunate to have among its citizens and leaders in these fields not only Chairman Miller, but such other distinguished men as the Chairman of the Atomic Energy Commission, Dr. Glenn Seaborg, and the Director of Defense Research and Engineering, Dr. Harold Brown.

In science and technology, developments continue to come at an accelerating pace. It was almost 50 years from the Wright Brothers' flight until we learned to build an airplane that could fly faster than sound, at 700 miles per hour. Little more than a decade was required to go from this 700 to 4,000 miles an hour in the X-15. In that same period, we also developed the power to reach out beyond the atmosphere and entered space with satellites that orbit around the earth at speeds of 17,000 miles per hour. By 1959, we were able to get our spacecraft up to speeds of 25,000 miles per hour, fast enough to overcome the earth's gravity and speed out into the solar system, never to return. Now, four years after the first satellites, we are able to launch spacecraft large enough to carry men in orbit about the earth.

Other nations are also making fast progress, and it has become ever more clear that to maintain our leadership, those institutions through which our citizens and experts cooperate -- governments, universities, and industrial corporations -- must continue and expand the extensive research and development required for the most rapid advancement of science and technology.

The earliest evidence of a new role and new requirements for large-scale organized efforts came with the Manhattan Project in World War II, in which this country led the way into the atomic age, first for military purposes and later for peace. Next came the National Science Foundation, which established the goal of stimulating all of science for the general welfare. In 1958, another milestone was passed with the creation of the National Aeronautics and Space Administration, a civilian arm of the Government which would work closely with the military services and have thorough scientific and technical competence in a new field opened by the capacity of the rocket.

This new agency, now three and a half years old, has been built by combining a number of existing organizations. We have brought together the research laboratories, scientists, and engineers of the National Advisory Committee for Aeronautics, the Jet Propulsion Laboratory of the California Institute of Technology, the Army's von Braun group at Huntsville, Alabama, and elements of the Naval Research Laboratory. In recent months, we have added to these groups a number of experienced, technically-oriented managers from industry to help weld this organization together for the efficient operation of our new national space effort.

The National Aeronautics and Space Act of 1958 established the basis for a long-range plan for civilian space exploration and development. Such a plan was laid out under the Eisenhower Administration. That plan called for a progression of space science research and exploration activities for a period of 10 years, from 1960 to 1970, and indicated the important areas for work in the post 1970 period.

The four major fields to be covered in the ten-year plan were: scientific satellites, lunar and planetary exploration, application satellites (in such areas as weather and communications), and manned space flight. Analysis and publication of the data in each of these fields was programmed.

Under the ten-year plan, the outstanding space missions projected for 1961 and 1962 were to be manned suborbital and orbital flight, impact landing of instruments on the moon, advances in planetary spacecraft, launching of a prototype active communication satellite, and launching of an orbiting astronomical observatory.

For 1963, a soft landing of instruments on the moon and the first launching of a million and one-half pound-thrust three-stage Saturn C-1.

For 1964, an orbiting astronomical observatory and an unmanned planetary reconnaissance.

For 1965, the major milestone was to be a prototype test for Apollo, using the Saturn C-1 as its booster, and which was conceived as a three-man, earth orbiting laboratory for use in the 1960's and as a basic vehicle for manned exploration of the moon in the 1970's.

For 1966, extending through 1970, there were to be flights by a three-stage Saturn C-2, capable of twice the payload of the C-1, flight tests of the Rover nuclear rocket, a planetary orbit by an unmanned spacecraft, manned Apollo earth-orbital flights, and a manned Apollo circumlunar flight.

Although the Eisenhower long-range plan called for a rapid development of space, by any normal standard, the manned lunar landing mission was considered to lie beyond 1970, and there was skepticism as to whether Russian accomplishments could really challenge us in space.

Mr. Eisenhower's doubts as to the value of manned space flight were expressed in his last budget message in these words:

> "Further testing and experimentation will be necessary to establish whether there are any valid scientific reasons for extending manned space flight beyond the Mercury program."

And he refused to include in his budget the funds required to build big boosters. This meant that the manned lunar landing (programmed to come after 1970) could not, in fact, take place under the most favorable circumstances before about the middle of the 1970's.

Even so, a reasonable estimate of expenditures to accomplish this ten-year plan, as it was laid out at the beginning of President Kennedy's term of office,would lie between twenty and twenty-five billion dollars.

This was the situation in early 1961, when the Soviet Union began a series of demonstrations that convinced all but the most confirmed skeptics of its rapid progress in space and its clear intention to use dramatic firsts to capture the imagination of the world and to clearly establish its image of leadership in science and technology. And in well-timed actions, they rattled their rockets and threatened any and all who might oppose them.

On February 4, 1961, a Soviet rocket launched a spacecraft weighing 14,292 pounds into orbit around the earth.

A week later, on February 12, another large Soviet spacecraft was placed in orbit, from which a deep space probe weighing 1,419 pounds was shot toward Venus.

Twice in the month of March, the Soviets launched spacecraft weighing more than 10,000 pounds carrying dog passengers. Each time, the spacecraft and dog were recovered from orbit.

In this same period, the United States demonstrated its own capacity through the launch of one Explorer, two Discoverers, and Transit 3-B.

Concurrent with these events and responsive to a directive by President Kennedy, an intensive study was carried out under the direction of Vice President Johnson, with the active participation of such senior officials as Defense Secretary Robert McNamara, Atomic Energy Chairman Glenn Seaborg, NASA Deputy Administrator Hugh Dryden, and myself.

On March 24, President Kennedy announced that if we were to retrieve our position in space, we could no longer proceed with the Mercury one-man space ship as if that were to be the end of our program, and that we must, even in a tight budget situation, commit ourselves to build the giant boosters required for multi-manned space flight. He submitted a request for an additional $125,670,000 to speed up the Saturn C-2 booster and the large million-and-a-half-pound thrust engine needed to furnish power for even larger boosters.

One day later, March 25, the United States launched its sixth satellite of the year. Explorer X, and the Russians launched their fourth Sputnik of the year, Sputnik X. Two weeks later, April 12, the Russians accomplished a manned orbit of the earth with Cosmonaut Gagarin, in the space ship Vostok.

Why was the Soviet Union able to do these things? The answer may be given in two words: rocket power.

The 14,000-pound payload launched by the Soviets in February 1961 was more than five times as heavy as the Mercury spacecraft in which John Glenn orbited the earth a year later. It was almost three times greater than the capacity of our most powerful currently available launch vehicle, the Atlas-Agena B. It remains as a challenge to any of us who may be lulled into complacency by pride in the brave deeds of our astronauts.

In the two months following the March 24th decision of the new Administration to step up the big booster program, a further intensive analysis of every facet of the program was conducted and the reorganized National Aeronautics and Space Council, under the leadership of its Chairman, Vice President Johnson, came increasingly into play. As a result, as you all know, on May 25, the President announced major new goals for the nation in space and new programs to achieve them.

In his request for appropriations to fund the new programs, the President asked increases for big engines and big boosters, for the Apollo three-man spacecraft, and to speed exploration of the environments of the earth and of the moon, and the space between. He requested funds for studies of the problems of spacecraft returning to earth from flights around the moon at atmospheric entry speeds as high as 25,000 miles an hour and for thorough studies of radiation problems, including an analysis of solar activity over the past fifty years in order to predict, if possible, the periods of extreme radiation which manned spaceflight must avoid.

Included also was an item of $50 million to expedite development of an active communications satellite system and to demonstrate transatlantic television.

The President requested funds for the Air Force to proceed with research on large solid-propellant motors and for the Atomic Energy Commission and NASA to expedite the Rover nuclear rocket engine.

One way of looking at the period since January of 1961 might be to say that the major actions taken by the new Administration to accelerate the national space effort were to initiate a new program to accomplish within the ten years of the 1960's approximately the same volume of space research and development, exploration, and beneficial applications as plans of the previous Administration envisioned in about fifteen years.

The President made his recommendations in a completely nonpartisan spirit, and Congress accepted them on the same basis. To both, the lessons of the Russian successes in space and in their propaganda use throughout the world, were clear.

In carrying out the national space program, uncertainty has ended and urgency has been added. Large boosters capable of putting heavy payloads into orbit or for use on other space tasks are being built. This means that if military missions are required in the future, the booster capacity will be available.

Let me hasten to add, however, that the policy of the United States to make every effort to use space for peaceful benefits to all mankind has not changed.

While it is important to recognize that without the big boosters -- Saturn, Nova, and Rover -- ranging in first-stage thrust from one and one-half million pounds to 12 or more million pounds, it is also important to recognize that we also need a versatile line of small and medium-sized rockets. The needs of the nation in space have now been classified as to type and size and a National Launch Vehicle Program developed to meet them.

The rockets in this program vary in size and power from the relatively small and inexpensive solid-fueled Scout, costing about one million dollars to build and launch, to the giant Nova, which is about as tall as the Mark Hopkins Hotel.

Obviously, we would not want to use a 10-ton truck to carry a few parcels, or, with a large load, to risk a failure by overloading a too-small truck. Similarly, we would not want to use Saturn or Nova to orbit a small,lightweight group of scientific instruments, or take the risk of failure involved in placing too much weight on any size rocket. It would be expensive and inefficient. By developing a family of launch vehicles, we can have available the right size for the job and avoid the expense of employing vehicles that are either larger and more powerful than necessary, or are marginal in power for the job at hand.

For each of these launch vehicles, missions have been assigned. These missions range from scientific research and exploration to tasks vitally necessary for the national defense. But the importance of these vehicles is not limited to the missions assigned at present -- vital as they may be. It is essential to bear in mind that three, four, five years or more may be required to develop a large launch vehicle, while the payloads generally require less time.

Thus, it is necessary to begin work on launch vehicles several years before beginning the development of payloads. The Secretary of Defense supports this National Launch Vehicle Program strongly, even though no military missions contemplated today would require such giant launch vehicles as the Saturn and Nova. But if such missions should be required in the future, he wants the assurance that the rocket power will be available to the nation when needed.

What is the National Launch Vehicle Program? At present, the program consists of 10 vehicles in ascending order of size -- Scout, Delta, Thor-Agena B, Atlas, Atlas-Agena B, Titan II, Centaur, Saturn C-1, Advanced Saturn, and Nova.

Responsibilities in this program have been divided between NASA and the Department of Defense. Development of six of the 10 vehicles is managed by NASA. These are Scout, Delta, Centaur, Saturn C-1, Advanced Saturn, and Nova. Development of the other four is managed by the Air Force as agent for the Department of Defense. Either the Air Force or NASA is assigned responsibility for serving as manager for each of these vehicles. But, all are available to any agency of the Government having work to do in space.

Now let me describe these 10 vehicles.

The smallestis Scout, a four-stage, solid-propellant vehicle, that can place a 150-pound satellite in orbit or can be used to send a larger probe into space near the earth. Scout has been under development for several years and is largely completed. It is now being employed for scientific satellite launchings.

Delta is the next vehicle in line. It can boost 500 pounds into a low earth orbit or smaller payloads to higher altitudes. Delta consists of a modified Thor, a liquid-fuel second stage, and a solid-fuel third stage. Delta is probably the most reliable launch vehicle the United States possesses, with a record of seven successful launchings in the last seven attempts.

The third vehicle is the Thor-Agena B, which can lift 1,600 pounds of payload into orbit and which has a restartable second stage that permits great precision in selecting an orbit. The Thor-Agena B has been employed by the Air Force for many missions and is now being made available for NASA use.

Fourth is the Atlas, which NASA employs to boost its Mercury spacecraft into orbit. The payload weight is about 2,700 pounds. The Atlas is a modified Air Force intercontinental ballistic missile. It burns liquid fuel and has one and a half stages. Three engines ignite on the ground but two of them fall away halfway through the powered portion of the flight. The Atlas will no longer be needed as a space booster after we phase out the Mercury spacecraft, and is not included in the National Launch Vehicle Program as a single stage booster beyond 1963 or 1964.

Next is Atlas-Agena B, in which the power of the Atlas is combined with the Agena B to produce a vehicle that has the capacity of placing 5,000 pounds in low orbit or sending 750 pounds into deep space. This will have continuing use for some years to come.

Vehicle No. 6 is the Titan II, tested by the Air Force for the first time last month. The Titan II is an intercontinental ballistic missile that employs storable liquid propellants. Because the propellants can be stored in the missile, it has the military advantage of instant readiness. As a space booster, the two-stage Titan II will be able to lift more than 6,000 pounds into orbit, also on short notice.

Seventh of America's launch vehicles is the Centaur, in which we are redesigning the Atlas to carry a radically different kind of upper stage, which burns liquid hydrogen as a propellant. Liquid hydrogen is a rocket fuel that provides great promise and at the same time involves great research and development difficulties. The temperature of liquid hydrogen is minus 423° Fahrenheit, just 36° above absolute zero. It is so cold that it must be carefully insulated from the liquid oxygen used as oxidizer -- itself having a temperature of 297° below zero.

Because of the efficiency of hydrogen as a fuel, Centaur will have the capacity of lifting 8,500 pounds into low orbit and about a ton into deep space.

The next vehicle -- the largest U.S. launch vehicle currently in the flight-test phase, the Saturn C-1 has been under development since 1958. This two-stage liquid-propellant rocket will be able to boost 15,000 to 20,000 pounds into a low earth orbit. The first two-stage test flight may take place next year. Late in 1963, we hope to get far enough along with its test to begin boosting useful payloads into space with the Saturn C-1. This will be the first time that we shall be able to exceed the Soviet accomplishment of February 1961.

The first flight test of the Saturn C-1 first stage, with upper stages filled with water as ballast, was conducted successfully last October 27. A similar test is scheduled to take place in the next few days. The second stage of Saturn C-1, which will fly next year, will burn liquid hydrogen, capitalizing on the experience developed in the Centaur program.

Ninth of the NASA vehicles is the mighty Advanced Saturn, which we began developing at the end of 1961. Advanced Saturn is a three-stage, liquid-propellant vehicle, which will have the capacity of lifting 100 tons into low orbit, or speeding 85,000 pounds out into deep space. The first stage, the largest rocket stage we know to be under development in the world today, will generate thrust of 7,500,000 pounds. Each of the five giant F-1 engines will have a thrust equal to the first stage of the Saturn C-1. The second and third stages of the Advanced Saturn again will capitalize on our experience with liquid hydrogen.

Finally, we come to the Nova, a three-stage vehicle that will be able to lift 375,000 pounds into low earth orbit, or speed 150,000 pounds out into deep space. Nova will stand about 280 feet tall, exclusive of payload, and its first stage will be about 50 feet in diameter. If Congress approves the funds recommended by President Kennedy, we plan to begin development of the Nova during the next 12 months.

We have already begun to develop the M-1 engine for the second stage, an enormously powerful liquid hydrogen-fueled power plant.

For the first stage,we plan to cluster eight F-1 liquid-propellant engines that will generate thrust of 12 million pounds.

NASA is also following very closely the progress of the Air Force in its research and development of large solid-propellant motors, As this research progresses, the nation will undoubtedly want to consider the application of solid propulsion to the lowest stage of a large launch vehicle such as Nova, thus adding another unit to the launch vehicle program.

Now I should like to mention some typical missions for the vehicles in this national program. Last fall, the Scout launched a 94-pound spacecraft to an altitude of more than 4,000 miles, which transmitted back to earth valuable scientific information about the ionosphere. Later this year, a Scout will boost a satellite to measure micrometeorites, or cosmic dust particles in space.

The Delta launches scientific research and developmental satellites such as the four already launched in the highly successful TIROS weather series. In the near future, a Delta will boost the first international satellite, carrying a scientific payload designed and developed in Great Britain.

The Thor-Agena B will boost our advanced weather satellite, the Nimbus, into polar orbits from Point Arguello, California, beginning six to nine months from now.

The Atlas, as noted previously, lifts our Mercury spacecraft into orbit.

The Atlas-Agena B provides the boost power for our Ranger lunar-landing spacecraft. We will launch our fourth Ranger from Cape Canaveral very shortly.

The Titan II will provide the power for the second phase of America's manned space flight program, the two-man Gemini spacecraft. Flights of the Gemini may begin late in 1963 or early 1964.

The Centaur will make it possible for the United States to launch heavy payloads into deep space. For example, Centaur will provide the power to lift the 2,100-pound Surveyor, including auxiliary rockets that will enable it to make a soft landing on the moon.

The Saturn C-1 will boost the three-man Apollo spacecraft into orbit about the earth for both test and operational flights. The Apollo is the vehicle we are developing for our first long-life manned space station and for landing men on the moon. This week we have scheduled an interesting scientific experiment to be conducted at the same time as we carry out our second test flight with the Saturn. We plan to explode the 95 tons of ballast water carried in the dummy upper stages at an altitude of 65 miles. Such an explosion, creating an artificial cloud, may prove to be an impressive sight. But this is not a stunt. The experiment, planned by the NASA Office of Space Sciences, is intended to obtain information on the effect of a large mass of water on the lower ionosphere and upper atmosphere. It will take place after the Saturn engines have cut off and we have obtained all the developmental information possible. This experiment is an example of how we try to get the maximum value from every flight.

The more powerful Advanced Saturn will enable us to lift a specially-prepared Apollo for a flight around the moon, together with rockets that will make it possible to rapidly return if the sun should flare and send out dangerous bursts of radiation.

The Nova will have power enough to send the fully-equipped Apollo on a direct flight to a landing on the moon, with the power to return to earth. The Apollo spacecraft itself weighs about 12,000 pounds. But for round-trip lunar missions, the Apollo must carry two additional rockets -- one to slow the fall toward a landing, and another to take off from the moon. Consequently, a payload of 150,000 pounds must be boosted to a distance of 240,000 miles in space for the manned exploration trip to and from the moon.

Because of the long development time required for Nova, we are investigating an optional method of boosting the Apollo payload for a lunar landing. If we can perfect the technique of rendezvous and docking in earth orbit, the lunar payload can be launched separately in two packages by two Advanced Saturns and joined together. If this can be done, we may save as much as two years. However, there is no assurance that the rendezvous technique can be developed, or developed in time to justify slowing up Nova. Therefore, both are included in the launch vehicle program and both are needed in the post-1970 period.

Launch vehicles make up the most expensive portion of the national space effort, because of their sheer size and the time required to produce them. Boosting payloads into space with rockets requires the most efficient use of energy. Only one or two percent of the weight of current launch vehicles actually goes into orbit. The rest falls away. We can foresee considerable improvement in efficiency, however, with the development of the larger launch vehicle.

In the Nova, we expect that almost four percent of the gross weight will go into orbit. This development will reduce costs per pound.

What we require for the future are more efficient means of propulsion, which will increase the efficiency of our vehicles still further. One such means is the nuclear rocket, which employs the energy of an atomic reactor to heat hydrogen gas to a very high temperature at which it expands and exhausts with great force out a jet nozzle to provide high thrust. At present, the effectiveness of nuclear rocket propulsion is limited largely by the strength of the materials available to withstand the high temperatures involved.

As we solve these problems in the years ahead, we believe that by substituting nuclear-powered upper stages for those powered by chemical rockets, we can ultimately increase payloads by a factor of two or more.

Like many developments involving atomic energy, the nuclear rocket originated in the West, at the Los Alamos Scientific Laboratory of the Atomic Energy Commission. The AEC has responsibility for the development of the reactor for our nuclear rocket in Project Rover, and NASA has responsibility for the engine, which we call NERVA. We work very closely with the AEC and are constructing a Nuclear Rocket Development Test Station near the Commission site in Nevada.

It is quite apparent from a review of our National Launch Vehicle Program that these Western states have a great interest in the nation's space activity. NASA also has a number of Centers in these states -- Ames Research Center at nearby Moffett Field, the Jet Propulsion Laboratory at Caltech, the Flight Research Center at Edwards Air Force Base, the Nuclear Rocket Development Station, the launch facilities on the Pacific Missile Range, tracking stations at San Nicholas Island off Southern California, far to the north in Alaska, and in Hawaii.

These facilities are required to do research and manage this large space effort. But by far the bulk of our work is done under contracts with industry, universities, and other private organizations. For the Fiscal Year beginning July 1, President Kennedy has proposed a space budget totaling $5.5 billion. About two-thirds of this sum -- $3.78 billion -- would be obligated by NASA. More than 92 percent of the NASA budget would be spent under contracts with non-governmental entities.

The West clearly has a large stake in our national space effort. But I believe it is only fair to say that other regions of our country have become increasingly active in